

Remarks

Claims 1 to 14 are pending in this application. Applicants hereby cancel Claims 1 to 3 and 6 without prejudice. Applicants specifically reserve the right to file a continuation application directed to the claims cancelled in this amendment. Additionally, Applicants amend Claims 4, 5, 7 and 11. Applicants believe that no new matter has been added by the claim amendments. Claims 4, 5 and 7 to 14 are now presented for the Examiner's consideration.

Amendments to the Specification

The word "an" in paragraph 50, line 9, has been amended to "a" as requested by the Examiner.

Amendment to the Abstract

The word "said" has been removed from the Abstract as requested by the Examiner.

Amendments to the Claims

Method Claim 7 has been limited to require that the swing adsorption process is a TEPSA process. Support for this amendment is found in the application as filed in paragraph 9, which states that "the present invention ... is particularly suitable for use with ... TEPSA systems".

Further, detail of the TEPSA process based on page 3 of the application has been included in the claim, in particular that:

- at least two components including a less strongly adsorbed component and a more strongly adsorbed component are adsorbed from the gas mixture;
- heated regeneration gas is passed to desorb the less strongly adsorbed component;
- heating is then terminated and regeneration gas is passed at a lower pressure than the pressure during adsorption to desorb the more strongly adsorbed component.

Apparatus Claim 4 has been amended correspondingly to require that the apparatus comprises control means for operating a TEPSA process. Support for this amendment is found in previous Claim 6, which indicated that the control means could operate the apparatus to perform TEPSA.

The references in Claims 4 and 7 to "the or each heater element" and "said heater element" have been amended to "the at least one heater element" to address the Examiner's objection of lack of antecedent basis.

The reference in Claim 5 to "said adsorption vessels" has been amended to "adsorption vessels" to address the Examiner's objection of lack of antecedent basis.

The reference in Claim 11 to "the heater element or elements" has been amended to "the at least one heater element" to address the Examiner's objection of lack of antecedent basis.

#### Prior Art Rejection

Original Claims 1 to 14 were rejected under 35 USC 102(b) as being anticipated by EP 1072303 and US 5768897 (Rainville et al.), and original Claims 1 to 7 were rejected under 35 USC 102(b) as being anticipated by US 4601114 (Noguchi) and GB 1469720. Applicants respectfully traverse these rejections and request reconsideration in the light of the amendments to the claims and the arguments provided below.

#### **US 5768897**

Claims 4 and 7 are novel over this document for the following reasons.

First, the claims require that the heater element is contained in the inlet nozzle. In the apparatus of US 5768897, the embodiment of Fig. 1 has the heater (146, col. 3, line 47) inside the adsorber vessel and not in a nozzle. Fig. 2 is similar. The embodiment of Fig. 3 has the heater (386, col. 11, line 9) positioned on the other side of a manifold connecting to both adsorber vessels and not in an inlet nozzle (similar to prior art diagram Fig. 1 of the present application).

Second, the claims require a TEP SA process. US 5768897 discloses a TSA process.

TSA is defined on page 2 of the present application:

"In TSA, the cycle time is extended [compared with PSA] and the heat pulse ... is allowed to proceed out of the downstream end of the adsorbent bed during the feed or on-line period. To achieve regeneration it is therefore necessary to supply heat to desorb the adsorbed gas component. To this end, the regenerating gas used is

heated for a period to produce a heat pulse moving through the bed counter-current to the normal feed direction. This flow of heated regenerating gas is usually followed by a flow of cool regenerating gas which continues the displacement of the heat pulse through the bed towards the upstream end."

In US 5768897, it is stated that "Second heater is activated, for a selected time, to raise the temperature of the air to a higher level ... As explained below, second heater is generally activated for only a selected regeneration heater time during each cycle. Generally, second heater will be turned off for a selected cool down time... The air, after passing over heater, flows through second desiccant. The air flowing through second desiccant performs a drying, or regeneration, function." (cols. 5 to 6).

This description makes it clear that the process of this document is a TSA process since heated regenerating gas is used for desorption, followed by cooling. Thus, even though this document does not use the term "TSA", it would be immediately clear to the skilled person that this documents discloses a TSA process.

TEPSA is defined on page 3 of the present application:

"A further variant on the TSA process known as TEPSA is described in US 5614000. Here, two different gas components such as water and carbon dioxide are adsorbed during the on-line period. A heated regenerating gas is fed during regeneration counter-current to the feed direction to produce a heat pulse travelling in the counter-current direction to desorb the less strongly adsorbed of the two adsorbed components. Heating of the regenerating gas is then terminated and feeding of the regenerating gas continues to allow the more strongly adsorbed component to be desorbed by pressure swing desorption, the regenerating gas being fed at a pressure lower than the pressure during the on-line period."

A TEPSA process thus requires that two components are adsorbed, one of which is desorbed by heated regenerating gas and the other of which is desorbed by unheated lower pressure regenerating gas. In US 5768897, a single component is adsorbed and desorbed by heated regenerating gas. This is not a TEPSA process.

Thus, Claims 4 and 7 are novel over US 5768897. Dependent Claims 5 and 8 to 14 are also novel.

These claims are also inventive over US 5768897 for the following reasons.

First, there is no suggestion in US 5768897 that the position of the heater could be moved. It was a contribution of the present inventors to appreciate that positioning the heater inside the adsorber as in US 5768897 Figs. 1 and 2 gives rise to the maintenance difficulties discussed in paragraph 14 of the present application, and that positioning the heater remote from the adsorber as in US 5768897 Fig. 3 gives rise to the heating difficulties discussed in paragraph 13. The invention of Claims 4 and 7 has the advantage that these maintenance and heating difficulties are overcome.

Second, there is no suggestion in US 5768897 that the TSA process could be changed to a TEPSA process.

US 5768897 deals with a method for dehumidifying air (abstract). Water is the only component which needs to be removed from the air. The document teaches that this is done using a TSA process, and does not identify any disadvantages with such a process or suggest that another process could be used.

Even if the skilled person did seek an alternative to the TSA process of US 5768897, he would of course seek an alternative which was appropriate for removing water from air. As explained above, TEPSA is a process for removing two components from a feed gas stream. In US 5614000 (referred to in the present application) it is stated that TEPSA "is applicable to essentially any situation in which a gas stream contains a first contaminating adsorbent which will adsorb strongly on a solid adsorbent and a second contaminating component which will adsorb significantly less strongly" (col. 3, last paragraph). Therefore, it is not an appropriate process for removing water (a single component) from air. Thus, there is no motivation to use a TEPSA process.

The use of a TEPSA process has the advantage that two components can be removed from a feed gas stream. This is useful for example in removing water and carbon dioxide from air, for example prior to cryogenic distillation. TEPSA requires relatively little energy to heat regeneration gas, particularly when the heater is positioned in the inlet nozzle as in the current invention so that heating of apparatus is minimized.

Thus, Claims 4 and 7 are inventive over the prior art documents. Dependent Claims 5 and 8

to 14 are also inventive.

#### **GB1469720**

Claims 4 and 7 are novel over this document for the following reasons.

First, the claims require that the heater element is contained in the inlet nozzle. In the apparatus of GB 1469720 Fig. 1 has the heater (electric heater 3, page 2, col. 1, line 35) inside the adsorber vessel and not in a nozzle.

Second, the claims require a TEP SA process. GB 1469720 discloses a TSA process.

In GB 1469720, it is stated that "The heater in column 1 and the blower are now started... the blower feeds air upwardly over the heater in column 1. The heated air serves as a drying agent ... After an adequate drying period, the heater of column 1 and the blower can be turned off so that the drying agent can be cooled off." (page 2, col. 2).

This description makes it clear that the process of this document is a TSA process since heated regenerating gas is used for desorption, followed by cooling. Thus, even though this document does not use the term "TSA", it would be immediately clear to the skilled person that this documents discloses a TSA process. For the reasons explained in connection with US 5768897 above, this is not a TEP SA process.

Thus, Claims 4 and 7 are novel over GB 1469720. Dependent Claims 5 and 8 to 14 are also novel.

These claims are also inventive over GB 1469720 for the following reasons.

First, there is no suggestion in GB 1469720 that the position of the heater could be moved. It was a contribution of the present inventors to appreciate that positioning the heater inside the adsorber as in GB 1469720 gives rise to the maintenance difficulties discussed on page 4, last paragraph of the present application. The invention of Claims 4 and 7 has the advantage that these maintenance difficulties are overcome.

Second, there is no suggestion in GB 1469720 that the TSA process could be changed to a TEPSA process.

GB 1469720 deals with an apparatus for drying air (Claim 1). Water is the only component which needs to be removed from the air. The document teaches that this is done using a TSA process, and does not identify any disadvantages with such a process or suggest that another process could be used.

Even if the skilled person did seek an alternative to the TSA process of GB 1469720, he would of course seek an alternative which was appropriate for removing water from air. As explained above, TEPSA is a process for removing two components from a feed gas stream. Therefore, it is not an appropriate process for removing water (a single component) from air. Thus, there is no motivation to use a TEPSA process.

As explained above, the use of a TEPSA process has the advantage that two components can be removed from a feed gas stream. This is useful for example in removing water and carbon dioxide from air, for example prior to cryogenic distillation. TEPSA requires relatively little energy to heat regeneration gas, particularly when the heater is positioned in the inlet nozzle as in the current invention so that heating of apparatus is minimized.

Thus, Claims 4 and 7 are inventive over the prior art documents. Dependent Claims 5 and 8 to 14 are also inventive.

#### **EP 1072303**

An English translation of EP 1072303 is enclosed for the Examiner's reference.

Claims 4 and 7 are novel over this document for the following reasons.

EP 1072303 relates to a catalytic filter rather than an adsorbent (abstract). No swing adsorption process involving a desorption step, let alone a TEPSA swing adsorption process as required by the claims, is disclosed.

The filter of EP 1072303 removes dust from the flue gas and catalytically converts nitric

oxide and ammonia to nitrogen and water (paragraph 20 and Fig. 3). There is no disclosure of adsorption of a more strongly adsorbed and a less strongly adsorbed component as required in a TEPESA process.

The regeneration step involves thermal and mechanical treatment (paragraph 33) and serves to regenerate the catalyst and to remove particles from the filter surface (paragraph 34) rather than to effect desorption.

EP 1072303 does not disclose the use of a two stage regeneration process using first heated regenerating gas and second unheated lower pressure regenerating gas as required in a TEPESA process.

Therefore, Claims 4 and 7 are novel over EP 1072303. Dependent Claims 5 and 8 to 14 are also novel.

These claims are also inventive over GB 1469720 for the following reasons.

EP 1072303 does not provide a good starting point for an inventive step attack, since this document does not lie in the correct technical field. To reach the invention of Claims 4 and 7 starting from this document, it would be necessary to replace the catalytic filter (which is central to the invention of EP 1072303) with an adsorbent, and to carry out a TEPESA process. The skilled person would have no motivation to do this.

Thus, Claims 4 and 7 are inventive over the prior art documents. Dependent Claims 5 and 8 to 14 are also inventive.

#### **US 4601114**

Claims 4 and 7 are novel over this document for the following reasons.

First, the claims require that the heater element is contained in the inlet nozzle. There is no disclosure that the heaters 25, 35 of the apparatus of US 4601114 are contained in inlet nozzles. The figures of US 4601114 are schematic and do not show clearly the position of the heaters.

Second, the claims require a TEP SA process. US 4601114 discloses a TSA process.

In US 4601114, it is stated that during regeneration "The heated air immediately enters into the adsorbing column and desorbs, from the adsorbent, the moisture which has been adsorbed by the adsorbent during the previous adsorbing treatment cycle of the adsorbing treatment unit... After completion of the above-mentioned desorbing treatment, the adsorbing treatment unit is subsequently subjected to a cooling treatment ... The minor part of the drying air that flows into the adsorbing treatment unit cools the adsorbing column, which has become hot due to the desorbing treatment." (cols. 7 to 8).

This description makes it clear that the process of this document is a TSA process since heated regenerating gas is used for desorption, followed by cooling. Thus, even though this document does not use the term "TSA", it would be immediately clear to the skilled person that this documents discloses a TSA process. For the reasons explained in connection with US 5768897 above, this is not a TEP SA process.

Thus, Claims 4 and 7 are novel over US 4601114. Dependent Claims 5 and 8 to 14 are also novel.

These claims are also inventive over US 4601114 for the following reasons.

First, there is no suggestion in US 4601114 that the heater could be positioned in the inlet nozzle. It was a contribution of the present inventors to appreciate that this position was advantageous, as discussed above.

Second, there is no suggestion in US 4601114 that the TSA process could be changed to a TEP SA process.

US 4601114 deals with a method for demisting air to be used in drying synthetic plastic material (title). Water is the only component which needs to be removed from the air. The document teaches that this is done using a TSA process, and does not identify any disadvantages with such a process or suggest that another process could be used.

Even if the skilled person did seek an alternative to the TSA process of US 4601114, he would of course seek an alternative which was appropriate for removing water from air. As explained above, TEPSA is a process for removing two components from a feed gas stream. Therefore, it is not an appropriate process for removing water (a single component) from air. Thus, there is no motivation to use a TEPSA process.

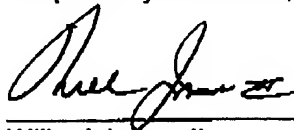
As explained above, the use of a TEPSA process has the advantage that two components can be removed from a feed gas stream. This is useful for example in removing water and carbon dioxide from air, for example prior to cryogenic distillation. TEPSA requires relatively little energy to heat regeneration gas, particularly when the heater is positioned in the inlet nozzle as in the current invention.

Thus, Claims 4 and 7 are inventive over the prior art documents. Dependent Claims 5 and 8 to 14 are also inventive.

#### Conclusion

In view of the foregoing remarks, Applicants respectfully submit that the claims are now in condition for allowance. Further examination, and reconsideration and withdrawal of all outstanding rejections, is respectfully requested, and the Examiner is encouraged to issue a formal Notification of Allowance.

Respectfully submitted,



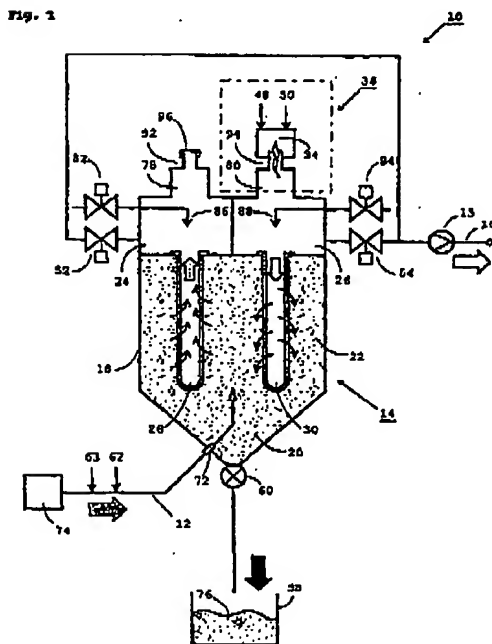
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Translation of EP01072303A1

### Method and device for regenerating catalysts

The method relates to regenerating a catalytic filter (28, 30), in particular as used in waste incineration plants for cleaning flue gases, suitable for mechanically separating out solids and for purifying or converting gaseous contaminants. In so doing, the catalytic filter (28, 30) is heated to a temperature above its operating temperature. At the same time, a carrier gas is fed to the catalytic filter (28, 30) resulting in the catalytic filter (28, 30) being regenerated by simultaneous thermal and mechanical treatment. The method according to the present invention, which is simple and inexpensive to carry out, thus enables the rapid restoration of the catalytic filter's mechanical and catalytic filter action by concurrent mechanical and thermal treatment. The device allows sequential regenerating of catalytic filters (28, 30) such that a flue gas cleaning system (10) can run without interruption even when catalytic filters (28, 30) are being regenerated.



### Description

[0001] The present invention relates to a method and a device in accordance with the precharacterising portion of claim 1 and/or 8.

[0002] In different branches of industry, for instance in waste incineration plants, hot flue gases are generated which contain solid and gaseous substances such as dust, flue ash, heavy metals, dioxins, furans as well as  $\text{SO}_2$ ,  $\text{SO}_3$ ,  $\text{NO}_x$ , CO and  $\text{CH}_x$ .

[0003] When subjecting wastes to thermal treatment, flue gases are cooled down to a temperature of approximately 220-240°C in a cooling boiler to recover the thermal energy. Before being discharged into the environment, the flue gases are to be purified of pollutants in line with legally-established maximum contamination values.

[0004] Highly-effective cleaning methods, which can be used alone or in combination, have been developed for each respective pollutant. To remove gaseous pollutants, absorbents, adsorbents and/or reagents are added, which, like the solid substances contained in the flue gas, also need to be eliminated. A filter is used to eliminate these substances. Catalysts for removing nitrogen oxides (so-called denitrification) are moreover provided to react with the added reagents.

[0005] Hose filters with any filter aids as needed have been used to date to filter out flue gases. Said hose filters, arranged downstream the cooling boiler and customarily operated at 200-220°C, needed to be removed and washed frequently, resulting in the corresponding interruptions to the functioning of the relevant filter units. Furthermore, the washing process resulted in further toxins entering the waste water, which thereafter had to be purified.

[0006] Filters having catalytic action, catalytic filters respectively, were then developed in particular for waste incineration plants which, as Fig. 3 shows, are suitable for the simultaneous de-dusting and denitrifying of flue gases. Such catalytic filters, known for example from DE-A1 36 34 360, combine the advantages of known precipitating techniques yet avoid the problems associated therewith and thus considerably reduce the overall costs of cleaning the gas. The catalytic filter, which serves as a high-performance filtering medium for de-dusting and as a solid catalyst for the noxious gas cleaning, preferably has an inorganic, e.g. a fibre-reinforced ceramic substrate consisting of  $\text{Al}_2\text{O}_3$ ,  $\text{SiO}_2$  and/or  $\text{SiC}$ , which is deeply doped, preferably over its entire cross-section, with substances having catalytic effect such as  $\text{V}_2\text{O}_5/\text{TiO}_2$ . Moreover, since the catalytic action of the filter not only effectively eliminates nitrogen oxides but also dioxins and furans, lime/carbon mixtures containing dioxin and furan no longer need to be disposed of as hazardous waste.

[0007] In testing catalytic filters, it was determined that after they have been in operation for a period of several weeks, not only did the filter develop a clearly increased loss of pressure but also a clear reduction in catalytic action, resulting in decreased gas flow and denitrification efficiency (typical reduction of approximately 25% after four weeks).

[0008] Regeneration of catalytic filters by washing has proven inadequate. Longer interruptions in the functioning of the relevant filter units furthermore result from this cleaning procedure as does waste water which needs to be purified. Yet a simple and inexpensive solution for regenerating catalytic filters is essential to its being used in industrial applications.

[0009] It is therefore the task of the present invention to provide a method and a device for fully regenerating catalytic filters in terms of filter and catalytic action quickly and at low cost.

[0010] This task is solved by the measures indicated in claim 1 and/or 8.

[0011] The inventive method, which is simple and inexpensive to carry out, surprisingly enables the catalytic filter's mechanical and catalytic filter action to be restored rapidly by concurrent mechanical and thermal treatment.

[0012] The catalytic filter can thereby be heated directly or indirectly by feeding in carrier gas. The supplying of heated carrier gas achieves an even distribution of heat without additional expenditure.

[0013] In a preferred configuration of the invention, the regeneration procedure can be realized in particularly simple manner with a burner, the excess air of which constitutes the carrier gas used for the mechanical and thermal treatment.

[0014] Pursuant the inventive regeneration, the increased loss in pressure for a catalytic filter, resulting from the deposits having developed during its foregoing operation, is again reduced. At the same time, the catalytic effect of the catalytic filter is restored.

[0015] Catalytic filters not needing to be removed for the inventive method of regeneration can be regenerated within just a few hours such that there is only a short interruption of function. The regeneration procedure and the respective device also allow the sequential regeneration of filter units so that the system can be operated without interruption during the regeneration procedure.

[0016] All told, the method and device according to the present invention yield a substantial reduction in operating costs.

[0017] The following will make reference to the figures in describing embodiments of the invention. Shown are:

Fig. 1 a device 10 in a preferred embodiment of two filter elements and two clean gas chambers which is suitable for regenerating catalytic filters in accordance with the present invention,

Fig. 2 a further device 100 suitable for regenerating catalytic filters in accordance with the present invention, and

Fig. 3 a schematic representation of catalytic filter action.

[0018] Fig. 1 shows a schematic representation of a device 10 in accordance with the present invention to which the flue gas to be cleaned is fed, e.g. from cooling boiler 74 connected downstream the incinerator of a waste incineration system. The flue gases, which contain solid and gaseous substances such as dust, flue ash, heavy metals, dioxins and furans as well as  $\text{SO}_2$ ,  $\text{SO}_3$ ,  $\text{NO}_x$ ,  $\text{CO}$ ,  $\text{CH}_x$ , are supplied via flue gas line 12 of cleaning device 14, by way of which the cited solid and gaseous substances are filtered out or converted into non-polluting gases by means of the catalytic filters 28, 30 described above. The flue gases thus cleaned are fed on through clean gas line 16 for further treatment.

[0019] Cleaning device 14 comprises a filter housing 18 exhibiting conically-shaped lower and cylindrically-shaped upper housing sections 20, 22 in the embodiment as shown, with inlet opening 72 connected to the flue gas line 12 at the underside and outlet openings at the top side into which are introduced the candle-type catalytic filters 28, 30 suitable for the simultaneous de-dusting and denitrification of flue gases as described at the outset.

[0020] As is apparent from Fig. 3, filter elements 28; 30 separate the dust 76 contained in the flue gas and convert  $\text{NO}$  and  $\text{NH}_3$  components into  $\text{N}_2$  as well as  $\text{H}_2\text{O}$ .

[0021] The cleaned flue gas is conveyed preferably by means of an induced-draft fan 15 from each catalytic filter 28; 30 through a closed clean gas chamber 24; 26 and a check valve 52; 54 to the clean gas line 16.

[0022] To provide a better overview, only two catalytic filters 28, 30 and two clean gas chambers 24, 26 are shown in Fig. 1 (and Fig. 2). Under normal conditions, however, often more than a hundred catalytic filters and multiple clean gas chambers are used.

[0023] One of the clean gas chambers 24; 26 shown in Fig. 1 is furthermore connected to a regeneration device 36 which performs the regeneration procedure.

[0024] A comparison of devices 10 and 100 as depicted in Figs. 1 and 2 shows that they differ only in the regeneration devices 36; 360 used.

[0025] In particularly advantageous manner, the carrier gas serving to heat catalytic filter 28; 30 can be that of the excess air of a gas burner 34 as shown in regeneration device 36 of Fig. 1. Each clean gas chamber 24; 26 is thereby provided with a combustion chamber 78; 80 onto which gas burner 34 can be positioned by means of connector 92; 94. Gas burner 34 is operated with a combustion gas 48, for example propane, as well as a high surplus of burner air 50. The negative pressure prevailing in filter housing 18 (approximately minus 30 mbar) sucks the hot carrier gas thus produced into the interior of filter housing 18 counter the normal direction of flow for the flue gas. The supplying of heated carrier gas to clean gas chambers 24, 26 can also ensue by means of a combustion chamber having a distribution line and the appropriate valves. In normal operation, connector 92; 94 is closed by means of cover 96.

[0026] Also conceivable for heating the carrier gas, however, is the regeneration device 360 shown in Fig. 2. To this end, a gas supply unit 46 feeds carrier gas through feed

line 40 and check valve 44 into the associated clean gas chamber 26 where it is heated by heating device 340 and thereafter absorbed into catalytic filter 30. Heating device 340 is preferably a heating member heated by steam or electric current. Additionally conceivable is the use of microwave emitters which, instead of heating the carrier gas, heat catalytic filters 28, 30 directly. Arranging heating member 340 external the clean gas chambers 24; 26 is likewise conceivable.

[0027] A discharge device 60 (e.g. a star feeder or screw-type conveyor) can feed the filter dust 76 accumulating in filter housing 18 to a filter dust receptacle 58.

[0028] The following will describe the functioning of cleaning device 14 in greater detail as well as the inventive method and device 10; 100.

[0029] Following cooling in cooling boiler 74, the flue gases produced by the incinerator of the waste incineration installation are introduced into the flue gas cleaning system 10; 100 through flue gas line 12. To reduce the nitrogen oxides contained in the flue gas, ammonia is introduced into the flue gas flow via line 63 at a metered dose determined on the basis of the nitrogen oxide values currently measured. Should additional absorption of acidic noxious gases such as HCl, HF or SO<sub>2</sub> be desired, a dry additive (e.g. calcium hydroxide or other alkali or alkaline earth oxides, hydroxides, carbonates or hydrogen carbonates) can also be added in through line 62. The flue gas preferably pre-treated in such a manner is drawn by the above-cited induced-draft fan 15 into inlet opening 72 of filter housing 18 and therein passes through catalytic filters 28 and 30. Catalytic filters 28 and 30 filter the dust 76 contained in the flue gas (see Fig. 3) while at the same time, the nitrogen oxides, carbon monoxides and hydrocarbons contained in the flue gas are converted into nitrogen, water vapour and carbon dioxide by the catalytic action of the layers to catalytic filters 28 and 30. The flue gas thus filtered and cleaned is conveyed by induced-draft fan 15 from catalytic filters 28 and 30 through each of the separate clean gas chambers 24; 26 into clean gas line 16.

[0030] It was determined upon testing of the catalytic filters 28, 30 that not only did the filters develop a clearly increased drop in pressure after they had been in operation for a period of several weeks, but also a clear reduction in catalytic action, the result of which was decreased gas flow and denitrification efficiency (typical reduction of approximately 25% after four weeks).

[0031] It is known that substances condensing in the pores of catalytic filters 28, 30 such as ammonium salts and heavy metal salts, for example, lead to the flow cross-section being diminished and thus increasing loss of pressure for catalytic filters 28 and 30 such that the flow of the flue gas is greatly impeded (to counteract this process, the flue flow is preferably kept constant via the corresponding power increase for induced-draft fan 15). The catalytic action of catalytic filters 28 and 30 is concurrently reduced, which is at least partly attributed to surface deposits on the catalytically-effective layers.

[0032] As soon as the drop in catalytic filter 28 and 30 performance (e.g. reduced denitrification action, reduced flue gas flow and/or increased pressure loss) exceeds a predefined value, regeneration device 36; 360 regenerates catalytic filters 28, 30 in application of the inventive method.

[0033] In the method according to the invention, a catalytic filter 28, 30 to be regenerated is heated to a temperature above its operating temperature. At the same time, a carrier gas is fed to the catalytic filter 28; 30 such that said catalytic filter 28; 30 is regenerated by simultaneous thermal and mechanical treatment.

[0034] The thermal treatment serves to restore the catalytic effectiveness of catalytic filter 28; 30. At the same time, the substances adhering to the filter surface (so-called filter cake) are partially sublimated and mechanically loosened and carried off from catalytic filter 28; 30 by the carrier gas.

[0035] The mechanical dissolution of the substances adhering to catalytic filter 28; 30 is thereby preferably aided by compressed air or gusts of compressed gas added to augment the carrier gas as necessary via an intermittent supply of a further gaseous medium. In the device of Fig. 1, compressed air lances 86, 88 are provided thereto, in which the associated valves 82, 84 open briefly to deliver blasts of compressed air to catalytic filters 28; 30. Typically, blasts of compressed gas at a pulse duration of approximately 25-100 ms are delivered every 5-10 minutes. It is also preferable for such gusts of compressed gas to be used regularly in normal operation.

[0036] Detached particles are then fed to the second catalytic filter 28 with the flue gas flow (see Figs. 1, 2) or fall to the bottom of filter housing 18 where discharge device 60 then feeds them to the filter dust receptacle 58.

[0037] As Figs. 1 and 2 show, the direction of flow for the carrier gas is preferably inverse the direction of flow for the flue gas. The adhering substances thus detach more readily from catalytic filter 28; 30 and are conveyed back into the flue gas to be cleaned.

[0038] As mentioned above, the temperature to which catalytic filter 28; 30 is to be heated during the regeneration procedure is higher than its operating temperature. Since the temperature-dependent processes differ for different gases such as CO, C<sub>3</sub>H<sub>8</sub> and NO as far as the degree of reduction to catalytic filters 28; 30, operating temperatures can be set by the user as required. Shown to be particularly advantageous are regeneration temperatures 50-200°C higher than the operating temperature of catalytic filters 28; 30.

[0039] At a catalytic filter 28; 30 operating temperature within the range of 200-250°C, a regeneration temperature of e.g. 300-400°C is selected for a regeneration procedure lasting about one to four hours, depending upon contamination. While selecting higher temperatures can in principle shorten the regeneration process, the regeneration temperature is preferably selected below the range at which damage to catalytic filter 28; 30 would occur.

[0040] The regeneration preferably ensues with a gas flow of approximately 50 m<sup>3</sup>/h based on a filter surface of 1m<sup>2</sup>. During the regeneration procedure, the connection between clean gas chamber 24; 26 through which the carrier gas flows and clean gas line 16 is disconnected so that no carrier gas can escape directly into clean gas line 16. As shown in Figs. 1 and 2, the carrier gas is sucked by means of induced-draft fan 15 through the catalytic filter 30 to be regenerated in filter housing 18 and from there

through the catalytic filter 28 in normal operation to clean gas line 16. The subsequent regeneration of the second catalytic filter 28 ensues in like manner.

[0041] With the method according to the invention, catalytic filters 28; 30 can be re-generated with little effort and thus inexpensively. The disruptive loss of pressure for catalytic filter 28; 30 as well as the reduction in catalytic action which results is remedied with simple means. The device as specified is particularly well suited for realizing the procedure.

[0042] The invention is applicable to regenerating catalytic filters provided for the cleaning of gases containing solid and/or gaseous pollutants. These contaminated gases, designated as flue gases for the sake of simplicity, can encompass any given exhaust gases.

#### List of Reference Numerals

10; 100	flue gas cleaning system
12	flue gas line
14	cleaning device
15	induced-draft fan
16	clean gas line
18	filter housing
20	lower housing section
22	upper housing section
24; 26	clean gas chamber
28; 30	catalytic filter
34; 340	heating device (gas burner)
36; 360	regeneration device (Fig. 1; Fig. 2)
40	feed line
44	check valve
46	gas supply unit
48	combustion gas (e.g. propane)
50	burner air
52; 54	check valve
58	filter dust receptacle
60	discharge device for dust
62	solid additive metering
63	ammonia metering
72	inlet opening
74	cooling boiler
76	dust
78; 80	combustion chamber
82; 84	valve for compressed air lance
86; 88	compressed air lance
92; 94	combustion chamber connector
96	removable cover for connector

### CLAIMS

1. Method for regenerating a catalytic filter (28, 30) as used in particular in waste incineration plants for cleaning flue gases and suited for mechanically separating out solids as well as purifying or converting gaseous contaminants,  
**characterized in that**  
the catalytic filter (28, 30) is heated to a temperature above its operating temperature and that a carrier gas is simultaneously fed to the catalytic filter (28, 30) such that said catalytic filter (28, 30) is regenerated by simultaneous thermal and mechanical treatment.
2. Method according to claim 1, **characterized in that**  
said catalytic filter (28, 30) is heated to a temperature which is 50-200°C above its operating temperature and/or to a temperature which is below that at which damage to said catalytic filter (28, 30) would occur.
3. Method according to claim 1 or 2, **characterized in that**  
said catalytic filter (28, 30) is heated directly by a radiant heater or a heating element (340) heated by means of steam or electric current or heated indirectly by hot carrier gas comprised of steam or air as the case may be.
4. Method according to claim 3, **characterized in that**  
the excess air of a burner (34) constitutes said carrier gas.
5. Method according to claim 1, 2, 3 or 4, **characterized in that**  
said carrier gas is passed through catalytic filter (28, 30) from the clean gas side.
6. Method according to one of the preceding claims, **characterized in that**  
pulse signals are superimposed on said carrier gas which effect a change in the carrier gas flow or an intermittent feed of a further gaseous medium.
7. Method according to one of the preceding claims for a system having a plurality of catalytic filters (28, 30), **characterized in that**  
the regeneration procedure is performed on some of said catalytic filters (28; 30) while other catalytic filters (30; 28) are in normal operation.

8. Device in particular for waste incineration plants for carrying out the method according to claim 1 having at least one catalytic filter (28; 30) for cleaning flue gas arranged in a filter housing (18) having an inlet opening (72) for a feed of flue gas which, subsequent filtering through said catalytic filter (28; 30), is fed to a clean gas line (16), **characterized in that** the catalytic filter (28; 30) is fed a carrier gas for the purpose of cleaning same and at least one heating device (34; 340) is provided for directly heating said catalytic filter (28; 30) or for indirectly heating same by means of a carrier gas to a temperature higher than the operating temperature of said catalytic filter (28; 30).
9. Device according to claim 8, **characterized in that** each single or group of catalytic filters (28, 30) is allocated a closed clean gas chamber (24; 26) through which the carrier gas can be fed to catalytic filters (28, 30) during the regeneration procedure and the flue gas purified by said catalytic filters (28, 30) can be fed to clean gas line (126) during normal operation.
10. Device according to claim 9, **characterized in that** heating device (340) is a gas burner operated with combustion gas (48) and an excess of burner air (50), via which the carrier gas generated can be fed through a combustion chamber (78; 80) of said clean gas chamber.
11. Device according to claim 9, **characterized in that** said heating device (340) is a radiant heater heated by steam or electric current, by means of which the carrier gas fed by a gas supply unit (46) is heated, or that the heating device (340) is a microwave emitter, by means of which the catalytic filters (28, 30) to be regenerated can be heated directly.
12. Device according to one of claims 8 – 11, **characterized in that** check valves (44; 82, 84) are provided which can be controlled such that the carrier gas can be made subject to pulse signals for changing the carrier gas feed or for intermittently supplying a further gaseous medium.
13. Device according to one of claims 8 – 12, **characterized in that** said catalytic filter (28, 30) is comprised of an inorganic material such as, where applicable, ceramic.
14. Device according to one of claims 8 – 13, **characterized in that** a boiler (74) is provided in which the flue gas is cooled prior to being fed to filter housing (18).